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(54) **DIGITAL TRANSCRIPTION SYSTEM UTILIZING ACCOUSTICAL DETECTORS HAVING APERTURES WITH A VERTICAL ORIENTATION RELATIVE TO THE WORK SURFACE**

DIGITALES TRANSKRIPTIONSSYSTEM MIT AKUSTISCHEN DETEKTOREN MIT ÖFFNUNGEN VON IM VERHÄLTNIS ZUR ARBEITSFLÄCHE VERTIKALER AUSRICHTUNG

SYSTÈME DE TRANSCRIPTION NUMÉRIQUE UTILISANT DES DÉTECTEURS ACOUSTIQUES AYANT DES OUVERTURES À ORIENTATION VERTICALE PAR RAPPORT À LA SURFACE DE TRAVAIL

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(56) References cited:
WO-A1-00/21025
JP-A- 3 138 720
US-A1- 2008 084 789
US-B1- 6 678 209
US-B2- 6 654 008
US-B2- 7 489 308

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Description

Background of the Invention

[0001] Acoustic-based distance measuring systems have been used to compute the position of a data entry object in a writing field for some time. For example, schemes that track and record the position of a pen on a white board are commercially available. As the user writes on the white board, the transcription system determines the location of the pen on the board and records the location for later use.

[0002] In such systems, a conventional marking pen of the type used with white boards is inserted into a housing that includes an acoustical transmitter and an infrared transmitter. As the user writes on the white board in the conventional manner, the transmitter sends a combination of acoustical and infrared pulses. Two receivers that are separated in space receive the signals generated by the housing. Each receiver measures the time difference between the time of arrival of the infrared pulse and the acoustical pulse to determine the distance of the housing from that receiver. These distance measurements are then combined to determine the position of the housing relative to the receivers.

[0003] Infrared is used for the light signals to avoid problems with background light in the area of use. The acoustical signals are typically in the ultrasound range so that the signals are beyond the human audible range. In addition, the higher frequencies provide better spatial resolution. Each acoustical receiver is typically constructed from a microphone such as a ceramic piezo microphone, PVDF films, a condenser microphone, an electrets condenser microphone (ECM), a moving coil microphone etc.

[0004] Unfortunately, the sensitivity of these devices as utilized in prior art systems is not completely omnidirectional at ultrasound frequencies. The variation in angle with respect to each sensor over the range of positions of the pen on the surface can be relatively large. Hence, angular variation in the gain of the ultrasound receivers can lead to increased errors due to noise and variation in the trigger point on the ultrasound pulse as a function of angle. The later type of error results in an error in the perceived delay time of the ultrasound signal, and hence, an error in the calculated distance from the sensor to the pen. In the extreme case, the microphone can have insufficient gain to detect the pen in some regions of a large writing surface. These gain problems can limit the size of the work surface that can be transcribed.

[0005] The invention is defined in the independent claims, which are characterised relative to the document US-7489308-B2.

[0006] The present invention includes a pen transcription system and method for using the same. The pen transcription system includes a receiver having first and second acoustical sensors mounted on a planar base and separated from one another, an EM detector, and a controller. The first and second acoustical sensors detect an acoustical signal emitted by a moveable signal source. The EM detector detects an EM signal that is synchronized with the acoustical signal. The controller measures the difference in time of detection between the EM signal and the acoustical signals detected by the first and second acoustical sensors. The first and second acoustical sensors each include a detector that generates an electrical signal in response to an acoustical signal in a predetermined frequency range and a housing surrounding the detector, the housing having an aperture defined by an axis. The acoustical sensor has a reception function that is symmetrical about the axis and the axis is substantially perpendicular to the base surface. The controller determines a position for the moveable signal source.

[0007] In one aspect of the invention, the receiver is fixed relative to a work surface on which the moveable signal source moves. The receiver can be located on the edge of the work surface or within the work surface so that the receiver detects signals when the moveable signal source is on at locations on all sides of the receiver. The receiver can also include a detector that is utilized by the controller to determine on which of the lines connecting the first and second acoustical sensors the moveable signal source is located. In one aspect of the invention, the detector is an EM detector that is directionally sensitive. In another aspect of the invention, the detector is a third acoustical sensor that is spaced apart from the first and second detectors and located off of the line connecting the first and second detectors. The third acoustical sensor can also be utilized to measure the height of the moveable signal source over the work surface.

[0008] In a still further aspect of the invention, one of the first and second acoustical sensors generates a signal that is proportional to the acoustic energy in the auditory acoustical band and the controller outputs a signal related to that signal. This signal can be utilized to record conversations in the vicinity of the receiver together with the position of the moveable signal source to provide a more complete record of a presentation made on the work surface.

Brief Description of the Drawings

[0009]

Figure 1 illustrates a prior art pen transcription system.

Figure 2 is a cross-sectional view of an acoustic sensor 30 that can be utilized in a pen transcription system.

Figure 3A is a top view of an acoustical sensor on work surface 60.

Figure 3B is a side view of the acoustical sensor as shown in Figure 3A.

Figure 4 is a top view of a pen transcription system according to one embodiment of the present invention.

Figure 5 is a top view of a pen transcription system according to another embodiment of the present invention.

Figure 6 illustrates a receiver 90 that utilizes one aspect of the present invention.

Figure 7 illustrates a receiver 100 that utilizes another aspect of the present invention.

Figure 8 is a top view of a pen transcription system according to another embodiment of the present invention.

Detailed Description of the Preferred Embodiments of the Invention

[0010] The manner in which the present invention provides its advantages can be more easily understood with reference to Figure 1, which illustrates a prior art pen transcription system. Pen transcription system 20 operates in conjunction with an input device 22 that has a housing that accepts a standard marking pen for writing on a work surface 21 such as a white board. Pen transcription system 20 is attached to one edge of work surface 21. Input device 22 emits both an electromagnetic (EM) signal and an acoustical signal in response to the user engaging a switch on the input device. Pen transcription system 20 includes an EM receiver 26 and two acoustical receivers, 24 and 25. A controller 27 computes the distance from input device 22 to each of the acoustical receivers by measuring the difference in arrival time between the acoustical signals received at the receivers and the EM signal. The computed position is forwarded to a client device 28 such as a computer for use in recording the material that was written on the work surface.

[0011] Refer now to Figure 2, which is a cross-sectional view of an acoustic sensor 30 that can be utilized in a pen transcription system. Acoustical sensor 30 includes a housing 31 in which a microphone 32 is located. Housing 31 has an opening 33 having a diameter D. The reception pattern for acoustical sensor 30 depends on the relationship of D to the wavelength, lambda (λ), of the acoustical signal being detected. The reception pattern for the case in which $D>>\lambda/(2\pi)$ is shown at 34. It should be noted that the pattern has a main lobe that is shown at 34 and side lobes 35. For an ultrasound signal at 40 kHz in air, $\lambda/(2\pi)$ is approximately 1.4mm. Prior art devices utilize acoustical sensors in which D is greater than this value, and hence, have reception (and transmission) patterns similar to that shown in Figure 2. This choice can improve the overall sound detection by increasing the energy that enters the cavity; however, the penalty for this choice is a reception pattern with very high variability as a function of angle. Define the direction normal to opening 33 as the normal direction to the acoustical sensor. This direction is indicated by the arrow shown at 36 in Figure 2. Prior art pen transcription systems utilize acoustical sensors in which the normal direction is parallel to the work surface. Hence, the sensitivity of the acoustical sensor can vary greatly as a function of the direction of the acoustical signal relative to the normal direction. This can lead to regions of the writing surface in which the pen's position cannot be reliably determined, particularly in the presence of background ultrasound sources such as motion detectors.

[0012] One aspect of the present invention is based on the observation that the reception function is only a function of the angle between the normal to the acoustical sensor and the transmitter; hence, if the acoustical sensor is mounted such that the normal to the acoustical sensor is orthogonal to the work surface, the variations in reception gain resulting from a nonuniform reception function can be substantially reduced. Refer now to Figures 3A and 3B, which illustrate the manner in which a vertically mounted acoustical sensor provides an improved reception function. Figure 3A is a top view of acoustical sensor 61 on work surface 60, and Figure 3B is a side view of acoustical sensor 61 on work surface 60. Referring to Figure 3B, a non-constant gain function results in the gain of acoustical sensor 61 being a function of angle 67; however, the gain will still be a constant, independent of angle 66 shown in Figure 3A for any given value of angle 67. In the arrangement shown in Figures 3A and 3B, angle 67 is set by the height of the acoustical transmitter 68 in pen 62 and the distance between the acoustical sensor 61 and pen 62. Since the height of transmitter 68 is set by the physical dimensions of the pen and the angle with which the user tilts the pen relative to the work surface, angle 67 is mainly a function of the distance from acoustical sensor 61 to the pen. Furthermore, the variation in angle 67 for various positions on the work surface is much less than the variations of angle 67 over the work surface when the acoustical sensor is mounted with normal 69 parallel to the work surface.

[0013] Refer now to Figure 4, which is a top view of a pen transcription system according to one embodiment of the present invention that utilizes this aspect of the present invention. Pen transcription system 70 tracks the position of a pen 72 on a work surface 71 in a manner analogous to that described above. Pen 72 emits a pair of pulses, an electro-magnetic pulse in the infrared pulse together with an acoustical pulse. The pulse pairs can be emitted periodically or in response to some event such as the user pressing a button on the pen or the pen being in contact with work surface 71. The pulse pairs are detected by a receiver 73 that includes a first acoustical sensor 74 and a second acoustical sensor 75 that are separated by a predetermined distance and mounted such that the normals of the acoustical sensors are perpendicular to work surface 71. To maximize the size of work surface 71, receiver 73 is typically positioned along

the side of work surface 71 at a location that is centered along one edge of work surface 71 such that a line from acoustical sensor 74 to acoustical sensor 75 is parallel to that edge.

[0014] Receiver 73 also includes an infrared receiver 76. Receiver 73 determines the distance of pen 72 from each of the acoustical sensors by comparing the time of arrival of the infrared pulse with the acoustical pulse received by each acoustical sensor. The position of pen 72, or information from which the position can be computed, is output by receiver 73, typically to a computer that stores the information and recreates the scene drawn by pen 72 on work surface 71 or takes other actions based on the position motion measurements.

[0015] By adding one more infrared or acoustical sensor to the receiver, a pen transcription system having twice the working area can be constructed. Refer now to Figure 5, which is a top view of a pen transcription system according to another embodiment of the present invention that utilizes this aspect of the present invention. Pen transcription system 80 is similar to pen transcription system 70 discussed above in that pen transcription system 80 includes a receiver 85 having first and second acoustical sensors shown at 87 and 88, respectively, that are mounted such that the normal to each acoustical sensor is perpendicular to work surface 81. Receiver 85 is mounted in the center of work surface 81, and hence, receiver 85 can receive signals from both sides of receiver 85 thereby effectively doubling the size of work surface 81 compared to work surface 71. Receiver 85 includes two infrared receivers 82 and 83. The direction from which each infrared receiver can receive signals is restricted by barrier 84 such that each infrared receiver can only receive signals from one half of the work surface. Hence, the side of the receiver on which the pen is located can be determined.

[0016] In the arrangement shown in Figure 5, the distance computation is carried out using the two acoustical sensors and whichever of the infrared receivers received the signal. However, arrangements in which a single infrared detector is used in the distance computations and a separate directional infrared receiver is used to determine on which side of the receiver the pen is located could also be constructed. Refer now to Figure 6, which illustrates a receiver 90 that utilizes this aspect of the present invention. Receiver 90 includes acoustical sensors 91 and 92, and an infrared receiver 93 that are used to compute the distance from a pen to each of the acoustical sensors when a pulse pair is received. Infrared receiver 93 can receive signals from both sides of receiver 93. A separate directionally specific infrared detector 94 is used to determine the location of the pen relative to receiver 90. In the embodiment shown in Figure 6, detector 94 includes two infrared detectors 95 and 96 separated by a barrier that limits the field of view of each infrared detector to one half the work surface on which receiver 90 is placed.

[0017] In embodiments that include two infrared detectors that are positioned such that only one of the two detectors receives the infrared signal from the pen at any given time, the signal from the other receiver can be used to enhance the infrared signal detection by providing a measurement of the background infrared noise. Ambient infrared noise is introduced by lighting and other equipment that utilize infrared signaling such as remote controls and infrared communication links used to transfer data between various digital devices. These sources are usually located off of the work surface and at some distance away from the infrared detectors. Hence, each infrared detector receives a background signal that is the same as that received by the other infrared detector.

[0018] In one aspect of the invention, the signal from each infrared detector is combined with the signal from the other infrared detector to provide a signal for that detector that is corrected for the common background noise. For example, the controller in the embodiment shown in Figure 5 could form a first difference signal by subtracting the signal from detector 82 from the signal from detector 83 and a second difference signal by subtracting the signal from detector 83 from the signal from detector 82. One of the difference signals will include a positive signal corresponding to the infrared pulse sent by pen, and the other will include a corresponding negative signal. By examining the difference signals, the controller determines the side of the receiver on which the pen is located.

[0019] The above-described embodiments utilize an arrangement in which the direction from which the infrared signal originates is utilized to determine on which side of the receiver the pen is located. However, embodiments that utilize an additional acoustical sensor to provide this information can also be constructed. Refer now to Figure 7, which illustrates a receiver 100 that utilizes this aspect of the present invention. Receiver 100 includes acoustical sensors 91, 92, and 101 and an infrared receiver 93. The distance from a pen to each of the acoustical sensors is computed using the difference in the time of arrival of the infrared signal and the acoustical signal from the acoustical sensor for each of the acoustical sensors. Since acoustical sensor 101 is not co-linear with acoustical sensors 91 and 92, the distances from the acoustical sensors to the pen and the location of the pen relative to receiver 100 can be uniquely determined from the three distance measurements.

[0020] It should also be noted that having a third acoustical detector enables the transcription system to determine the location of the pen in three-dimensions. That is, the height of the pen over the work surface can be determined. The height information can be used to determine if the pen is in contact with the work surface or positioned above the work surface. Accordingly, the controller can activate transcription only when the user is actually drawing on the work surface, i.e., the pen is in contact with the work surface or within some predetermined distance from the surface.

[0021] The acoustical transmitter in the pen operates

at an ultrasound frequency. The precise frequency depends on a number of factors. The frequency should be above the auditory range of human beings and domestic animals that are likely to be within range of the pen when the pen is operating. In addition, the frequency should be different from that of other ultrasound transducers in the area. Such transducers are often used in motion sensing devices that control lighting or burglar alarms. Finally, for any given power level in the pen, higher frequency transmitters tend to have shorter ranges. Hence, pen transcription systems that must measure position over larger work surfaces preferably utilize lower frequencies than pens that are required to operate over small area surfaces. In one aspect of the present invention, the pen includes an ultrasound transducer having a frequency between 30 KHz and 80 KHz, and more particularly between 40KHz and 80 KHz.

[0022] As noted above, the ultrasound frequency is preferably chosen to avoid background ultrasound sources such as those used in motion detectors. In one aspect of the present invention, the controller measures the acoustical spectrum being received by the receivers in the absence of the pen to determine if there are competing ultrasound sources. In such embodiments, the frequency of the ultrasound transducer in the pen can be varied in some predetermined range of frequencies either continuously or discretely. If one or more background sources are detected, the pen is set to a frequency that does not overlap with the background sources in question. The frequency selection can be communicated to the user by the client device shown in Figure 1 or by a separate frequency indicator on the receiver. For example, receiver 100 shown in Figure 7 could include a display 110 that displays the frequency channel that the pen is to utilize. The user can then set the pen frequency accordingly.

[0023] In the above-described embodiments that utilized an additional acoustical sensor to determine the location of the writing implement, the additional sensor was located on the receiver assembly that includes the other two acoustical sensors and the infrared detector. However, embodiments in which the additional acoustical sensor or sensors are located at remote locations with respect to the receiver assembly can also be constructed. Refer now to Figure 8, which illustrates another embodiment of a pen transcription system according to the present invention. Transcription system 150 includes a receiver 155 that is located in the interior of a work surface 71 and receives signals from a writing implement 72 as described above. Receiver 155 includes two acoustical sensors 156 and 157 and an infrared sensor 158. Transcription system 150 also includes two acoustical sensors, 152 and 159, that are located on the edge of work surface 71. The signals from these sensors are received by the same controller that processes the data from sensors 156-158. To simplify the drawing, the connections from sensors 152 and 159 have been omitted. The signals from one or both of sensors 152 and 159 can be utilized to determine the location of writing implement 72 relative to receiver assembly 155. In addition, the signals from sensors 152 and 159 can also be utilized in determining the position of writing implement 72. It should be noted that one of the acoustical sensors in sensor assembly 155 could be omitted in this embodiment.

[0024] In another aspect of the present invention, at least one of the acoustical sensors is sensitive to sound in the auditory frequency range, i.e., 50 to 2000 Hz. The controller utilizes this detector to provide a signal for recording the comments made by individuals within range of this acoustical sensor that can be included in the transcription record with the position of the pen as a function of time. A filter can be implemented, either in hardware or software, to remove sounds outside of this frequency range or a sub-range thereof that is used for the recording function.

[0025] The above-described embodiments of the present invention utilize light in the visible or infrared region of the optical spectrum. However, a source that emits electromagnetic radiation of other wavelengths could be utilized provided the emitted radiation pattern is directional. Accordingly, the term "light" will be defined to include any directional electromagnetic radiation unless a more specific range of wavelengths is indicated.

[0026] The above-described embodiments of the present invention have been provided to illustrate various aspects of the invention. However, it is to be understood that different aspects of the present invention that are shown in different specific embodiments can be combined to provide other embodiments of the present invention. In addition, various modifications to the present invention will become apparent to those skilled in the art from the foregoing description and accompanying drawings. Accordingly, the present invention is to be limited solely by the scope of the following claims.

Claims

1. Apparatus for tracking the position of a pen, said apparatus comprising a receiver comprising:

   a base having a planar base surface;
   first and second acoustical sensors (24, 25; 74, 75; 87, 88; 91, 92) that detect an acoustical signal emitted by a moveable signal source, said first and second acoustical sensors being mounted on said base and separated from one another;
   a first electromagnetic detector (26; 76; 82, 83; 94) that detects a first electromagnetic signal that is synchronized with said acoustical signal; and
   a controller (27) that measures the difference in time of detection between said first electromagnetic signal and said acoustical signals detected by said first and second acoustical sensors;

characterised in that said first and second acoustical sensors each comprise

a detector (32) that generates an electrical signal in response to an acoustical signal in a predetermined frequency range; and
a housing (31) surrounding that detector, said housing having an aperture defined by an axis, wherein said acoustical sensor has a reception function that is symmetrical about said axis, said axis being substantially perpendicular to said base surface.

2. The apparatus of Claim 1, wherein said controller (27) determines a frequency in said predetermined frequency range to be utilized by said moveable signal source based on a measurement of acoustical energy as a function of frequency in said predetermined frequency range in the absence of said moveable signal source.

3. The apparatus of Claim 1, wherein said receiver is fixed relative to a work surface (81) on which said moveable signal source moves and wherein said receiver is located at a point that is internal to said work surface, said moveable source being located on either side of a line joining said first and second acoustical sensors, and wherein said receiver comprises a detector (94) that is utilized by said controller to determine on which side of said line connecting said first and second acoustical sensors said moveable signal source is located.

4. The apparatus of Claim 3, wherein said detector is a second EM detector or a third acoustical sensor.

5. The apparatus of Claim 4, wherein said controller (27) combines signals from said first and second electromagnetic detectors to generate a timing signal that is corrected for background electromagnetic noise that is common to both of said first and second electromagnetic detectors.

6. The apparatus of Claim 1, further comprising determining a position for said moveable signal source on said work surface utilizing said controller.

7. The apparatus of Claim 1, wherein said receiver is located on an edge of said work surface.

8. A method for determining the position of a moveable signal source on a work surface, said method comprising: I

providing a receiver at a fixed location on said work surface, said receiver comprising
first and second acoustical sensors (24, 25; 74, 75; 87, 88; 91, 92) that detect an acoustical signal emitted by said moveable signal source, said first and second acoustical sensors being mounted on said work surface and separated from one another and
a first electromagnetic detector (26; 76; 82, 83; 94) that detects a first EM signal that is synchronized with said acoustical signal; and
measuring the difference in time of detection between said first EM signal and said acoustical signals detected by said first and second acoustical sensors,

characterized by:

measuring signals from said moveable source with said first and second acoustical sensors that each comprise:

a detector (32) that generates an electrical signal in response to an acoustical signal in a predetermined frequency range; and
a housing (31) surrounding that detector, said housing having an aperture (33) defined by an axis, wherein said acoustical sensor has a reception function that is symmetrical about said axis, said axis being substantially perpendicular to said work surface.

9. The method of Claim 8, further comprising measuring the acoustical energy in said predetermined frequency range in the absence of said moveable signal source and communicating a frequency in said predetermined frequency range at which said moveable signal source is to transmit said acoustical signal based on said energy measurement.

10. The method of Claim 9, wherein said receiver is located at a point that is internal to said work surface, said moveable source being located on either side of a line joining said first and second acoustical sensors, and determining said position comprises determining on which side of a line connecting said first and second acoustical sensors said moveable signal source is located.

11. The method of Claim 10, wherein determining on which side of said line said moveable signal source is located comprises detecting said EM signal in a detector that provides different signals when said moveable source is located on different sides of said line.

12. The method of Claim 11, further comprising combining signals from said first detector and a second EM detector to generate a corrected EM signal that is corrected for background EM noise that is common to both of said first and second EM detectors.

13. The method of Claim 10, wherein determining on which side of said line said moveable signal source is located comprises detecting said acoustical signal in a third acoustical sensor.

14. The method of Claim 8, further comprising determining the height of said moveable source above said work surface utilizing said controller.

15. The method of Claim 8, further comprising recording a signal related to an output of one of said acoustical sensors in an auditory frequency band utilizing said controller.

Patentansprüche

1. Vorrichtung zur Verfolgung der Position eines Stifts, die Vorrichtung umfassend einen Empfänger, welcher umfasst:

eine Basis mit einer ebenen Basisfläche;
erste und zweite akustische Sensoren (24, 25; 74, 75; 87, 88; 91, 92), welche ein akustisches Signal erfassen, das von einer beweglichen Signalquelle ausgesendet wird, wobei die ersten und zweiten akustischen Sensoren an der Basis montiert und voneinander getrennt sind;
einen ersten elektromagnetischen Detektor (26; 76; 82, 83; 94), welcher ein erstes elektromagnetisches Signal erfasst, das mit dem akustischen Signal synchronisiert ist; und
eine Steuerungseinheit (27), welche die Differenz bei der Erfassungszeit zwischen dem ersten elektromagnetischen Signal und den akustischen Signalen misst, welche durch die ersten und zweiten akustischen Sensoren erfasst werden;
dadurch gekennzeichnet, dass die ersten und zweiten akustischen Sensoren jeweils umfassen
einen Detektor (32), welcher ein elektrisches Signal als Reaktion auf ein akustisches Signal in einem vorgegebenen Frequenzbereich erzeugt; und
ein Gehäuse (31), welches den Detektor umgibt, wobei das Gehäuse eine durch eine Achse definierte Öffnung aufweist, wobei der akustische Sensor eine Empfangsfunktion hat, die symmetrisch zu der Achse ist, wobei die Achse im Wesentlichen senkrecht zu der Basisfläche ist.

2. Vorrichtung gemäß Anspruch 1, wobei die Steuerungseinheit (27) eine Frequenz in dem vorgegebenen Frequenzbereich ermittelt, die von der beweglichen Signalquelle genutzt werden soll, basierend auf einer Messung der akustischen Energie als Funktion der Frequenz in dem vorgegebenen Frequenzbereich beim Fehlen der beweglichen Signalquelle.

3. Vorrichtung gemäß Anspruch 2, wobei der Empfänger im Verhältnis zu einer Arbeitsfläche (81) fixiert ist, auf welcher sich die bewegliche Signalquelle bewegt, und wobei sich der Empfänger an einer Stelle befindet, die innerhalb der Arbeitsfläche liegt, wobei sich die bewegliche Quelle auf einer der Seiten einer Linie befindet, welche die ersten und zweiten akustischen Sensoren verbindet, und wobei der Empfänger einen Detektor umfasst (94), der von der Steuerungseinheit genutzt wird, um zu ermitteln, auf welcher Seite der Linie, welche die ersten und zweiten akustischen Sensoren verbindet, sich die bewegliche Signalquelle befindet.

4. Vorrichtung gemäß Anspruch 3, wobei der Detektor ein zweiter elektromagnetischer Detektor oder ein dritter akustische Sensor ist.

5. Vorrichtung gemäß Anspruch 4, wobei die Steuerungseinheit (27) die Signale von den ersten und zweiten elektromagnetischen Detektoren kombiniert, um ein Timing-Signal zu erzeugen, das hinsichtlich des elektromagnetischen Hintergrundrauschens korrigiert ist, welches für sowohl den ersten als auch den zweiten elektromagnetischen Detektor üblich ist.

6. Vorrichtung gemäß Anspruch 1, des Weiteren umfassend das Ermitteln einer Position für die bewegliche Signalquelle auf der Arbeitsfläche unter Verwendung der Steuerungseinheit.

7. Vorrichtung gemäß Anspruch 1, wobei sich der Empfänger an einem Rand der Arbeitsfläche befindet.

8. Verfahren zum Ermitteln der Position einer beweglichen Signalquelle auf einer Arbeitsfläche, das Verfahren umfassend:

das Bereitstellen eines Empfängers an einer festen Position auf der Arbeitsfläche, der Empfänger umfassend
erste und zweite akustische Sensoren (24, 25; 74, 75; 87, 88; 91, 92), welche ein akustisches Signal erfassen, das von der beweglichen Signalquelle ausgesendet wird, wobei die ersten und zweiten akustischen Sensoren auf der Arbeitsfläche montiert und voneinander getrennt sind; und
einen ersten elektromagnetischen Detektor (26; 76; 82, 83; 94), welcher ein erstes elektromagnetisches Signal erfasst, das mit dem akustischen Signal synchronisiert ist; und
das Messen der Differenz bei der Erfassungszeit zwischen dem ersten elektromagnetischen

Signal und den akustischen Signalen, welche durch die ersten und zweiten akustischen Sensoren erfasst werden;
gekennzeichnet durch:

das Messen der Signale von der beweglichen Quelle mit den ersten und zweiten akustischen Sensoren, die jeweils umfassen:

einen Detektor (32), welcher ein elektrisches Signal als Reaktion auf ein akustisches Signal in einem vorgegebenen Frequenzbereich erzeugt; und
ein Gehäuse (31), welches den Detektor umgibt, wobei das Gehäuse eine **durch** eine Achse definierte Öffnung (33) aufweist, wobei der akustische Sensor eine Empfangsfunktion hat, die symmetrisch zu der Achse ist, wobei die Achse im Wesentlichen senkrecht zu der Basisfläche ist.

9. Verfahren gemäß Anspruch 8, des Weiteren umfassend das Messen der akustischen Energie in dem vorgegebenen Frequenzbereich beim Fehlen der beweglichen Signalquelle und das Kommunizieren einer Frequenz in dem vorgegebenen Frequenzbereich, auf der die bewegliche Signalquelle das akustische Signal übertragen soll, auf der Basis dieser Energiemessung.

10. Verfahren gemäß Anspruch 9, wobei sich der Empfänger an einer Stelle befindet, die innerhalb der Arbeitsfläche liegt, wobei sich die bewegliche Quelle auf einer der Seiten einer Linie befindet, welche die ersten und zweiten akustischen Sensoren verbindet, und wobei das Ermitteln der Position umfasst, dass ermittelt wird, auf welcher Seite einer Linie, welche die ersten und zweiten akustischen Sensoren verbindet, sich die bewegliche Signalquelle befindet.

11. Verfahren gemäß Anspruch 10, wobei das Ermitteln, auf welcher Seite der Linie sich die bewegliche Signalquelle befindet, das Erfassen des elektromagnetischen Signals in einem Detektor umfasst, der unterschiedliche Signale bereitstellt, wenn sich die bewegliche Quelle auf unterschiedlichen Seiten der Linie befindet.

12. Verfahren gemäß Anspruch 11, des Weiteren umfassend das Kombinieren der Signale von den ersten und zweiten elektromagnetischen Detektoren, um ein korrigiertes elektromagnetisches Signal zu erzeugen, das hinsichtlich des elektromagnetischen Hintergrundrauschens korrigiert ist, welches für sowohl den ersten als auch den zweiten elektromagnetischen Detektor üblich ist.

13. Verfahren gemäß Anspruch 10, wobei das Ermitteln, auf welcher Seite der Linie sich die bewegliche Signalquelle befindet, das Erfassen des akustischen Signals in einem dritten akustischen Sensor umfasst.

14. Verfahren gemäß Anspruch 8, des Weiteren umfassend das Ermitteln der Höhe der beweglichen Signalquelle über der Arbeitsfläche unter Verwendung der Steuerungseinheit.

15. Verfahren gemäß Anspruch 8, des Weiteren umfassend das Aufzeichnen eines Signals in Bezug auf eine Ausgabe eines der akustischen Sensoren in einem auditiven Frequenzband unter Verwendung der Steuerungseinheit.

Revendications

1. Appareil pour suivre la position d'un stylo, ledit appareil comprenant un récepteur comprenant :

une base ayant une surface de base planaire ;
des premiers et deuxièmes capteurs acoustiques (24, 25 ; 74, 75 ; 87, 88 ; 91, 92) qui détectent un signal acoustique émis par une source de signal mobile, lesdits premiers et deuxièmes capteurs acoustiques étant montés sur ladite base et séparés les uns des autres ;
un premier détecteur électromagnétique (26 ; 76 ; 82, 83 ; 94) qui détecte un premier signal électromagnétique qui est synchronisé avec ledit signal acoustique ; et
un contrôleur (27) qui mesure la différence de moment de détection entre ledit premier signal électromagnétique et lesdits signaux acoustiques détectés par lesdits premiers et deuxièmes capteurs acoustiques ;

caractérisé en ce que lesdits premiers et deuxièmes capteurs acoustiques comprennent chacun

un détecteur (32) qui génère un signal électrique en réponse à un signal acoustique dans une gamme de fréquences prédéterminée ; et
un logement (31) entourant ce détecteur, ledit logement ayant une ouverture définie par un axe, dans lequel ledit capteur acoustique a une fonction de réception qui est symétrique autour dudit axe, ledit axe étant substantiellement perpendiculaire à ladite surface de base.

2. L'appareil de la revendication 1, dans lequel ledit contrôleur (27) détermine une fréquence dans ladite gamme de fréquences prédéterminée devant être utilisée par ladite source de signal mobile sur la base d'une mesure de l'énergie acoustique en fonction d'une fréquence dans ladite gamme de fréquences

prédéterminée en l'absence de ladite source de signal mobile.

3. L'appareil de la revendication 1, dans lequel ledit récepteur est fixe relativement à une surface de travail (81) sur laquelle ladite source de signal mobile se déplace et dans lequel ledit récepteur est situé à un point qui est interne à ladite surface de travail, ladite source mobile étant située de l'un ou l'autre côté d'une ligne joignant lesdits premiers et deuxièmes capteurs acoustiques, et dans lequel ledit récepteur comprend un détecteur (94) qui est utilisé par ledit contrôleur pour déterminer sur laquelle côté de ladite ligne raccordant lesdits premiers et deuxièmes capteurs acoustiques ladite source de signal mobile est située.

4. L'appareil de la revendication 3, dans lequel ledit détecteur est un deuxième détecteur électromagnétique ou un troisième capteur acoustique.

5. L'appareil de la revendication 4, dans lequel ledit contrôleur (27) combine des signaux desdits premier et deuxième détecteurs électromagnétiques pour générer un signal de temporisation qui est corrigé du bruit électromagnétique de fond qui est commun auxdits premier et deuxième détecteurs électromagnétiques.

6. L'appareil de la revendication 1, comprenant en outre déterminer une position pour ladite source de signal mobile sur ladite surface de travail en utilisant ledit contrôleur.

7. L'appareil de la revendication 1, dans lequel ledit récepteur est situé sur un bord de ladite surface de travail.

8. Un procédé pour déterminer la position d'une source de signal mobile sur une surface de travail, ledit procédé comprenant :

fournir un récepteur à un emplacement fixe sur ladite surface de travail, ledit récepteur comprenant
des premiers et deuxièmes capteurs acoustiques (24, 25 ; 74, 75 ; 87, 88 ; 91, 92) qui détectent un signal acoustique émis par ladite source de signal mobile, lesdits premiers et deuxièmes capteurs acoustiques étant montés sur ladite surface de travail et séparés les uns des autres ; et
un premier détecteur électromagnétique (26 ; 76 ; 82, 83 ; 94) qui détecte un premier signal électromagnétique qui est synchronisé avec ledit signal acoustique ; et
mesurer la différence de moment de détection entre ledit premier signal électromagnétique et lesdits signaux acoustiques détectés par lesdits premiers et deuxièmes capteurs acoustiques ;

caractérisé par :

mesurer les signaux provenant de ladite source mobile avec lesdits premiers et deuxièmes capteurs acoustiques qui comprennent chacun :

un détecteur (32) qui génère un signal électrique en réponse à un signal acoustique dans une gamme de fréquences prédéterminée ; et
un logement (31) entourant ce détecteur, ledit logement ayant une ouverture (33) définie par un axe, dans lequel ledit capteur acoustique a une fonction de réception qui est symétrique autour dudit axe, ledit axe étant substantiellement perpendiculaire à ladite surface de travail.

9. Le procédé de la revendication 8, comprenant en outre mesurer l'énergie acoustique dans ladite gamme de fréquences prédéterminée en l'absence de ladite source de signal mobile et communiquer une fréquence dans ladite gamme de fréquences prédéterminée à laquelle ladite source de signal mobile doit transmettre ledit signal acoustique sur la base de ladite mesure d'énergie.

10. Le procédé de la revendication 9, dans lequel ledit récepteur est situé à un point qui est interne à ladite surface de travail, ladite source mobile étant située de l'un ou l'autre côté d'une ligne joignant lesdits premiers et deuxièmes capteurs acoustiques, et déterminer ladite position comprend déterminer de quel côté d'une ligne raccordant lesdits premiers et deuxièmes capteurs acoustiques ladite source de signal mobile est située.

11. Le procédé de la revendication 10, dans lequel déterminer de quel côté de ladite ligne ladite source de signal mobile est située comprend détecter ledit signal électromagnétique dans un détecteur qui fournit différents signaux quand ladite source mobile est située sur des côtés différents de ladite ligne.

12. Le procédé de la revendication 11, comprenant en outre combiner les signaux provenant dudit premier détecteur et d'un deuxième détecteur électromagnétique pour générer un signal électromagnétique corrigé qui est corrigé du bruit électromagnétique de fond qui est commun aux premier et deuxième détecteurs électromagnétiques.

13. Le procédé de la revendication 10, dans lequel déterminer de quel côté de ladite ligne ladite source de signal mobile est située comprend détecter ledit si-

gnal acoustique dans un troisième capteur acoustique.

14. Le procédé de la revendication 8, comprenant en outre déterminer la hauteur de ladite source de signal mobile au-dessus de ladite surface de travail en utilisant ledit contrôleur.

15. Le procédé de la revendication 8, comprenant en outre enregistrer un signal lié à une sortie de l'un desdits capteurs acoustiques dans une bande de fréquences auditoire en utilisant ledit contrôleur.

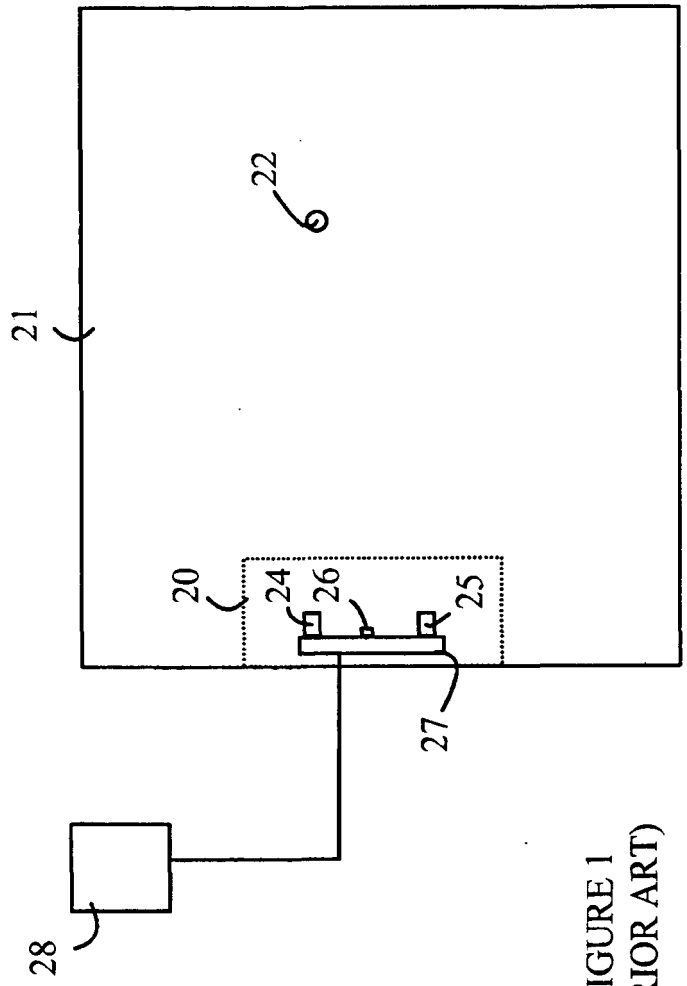


FIGURE 1
(PRIOR ART)

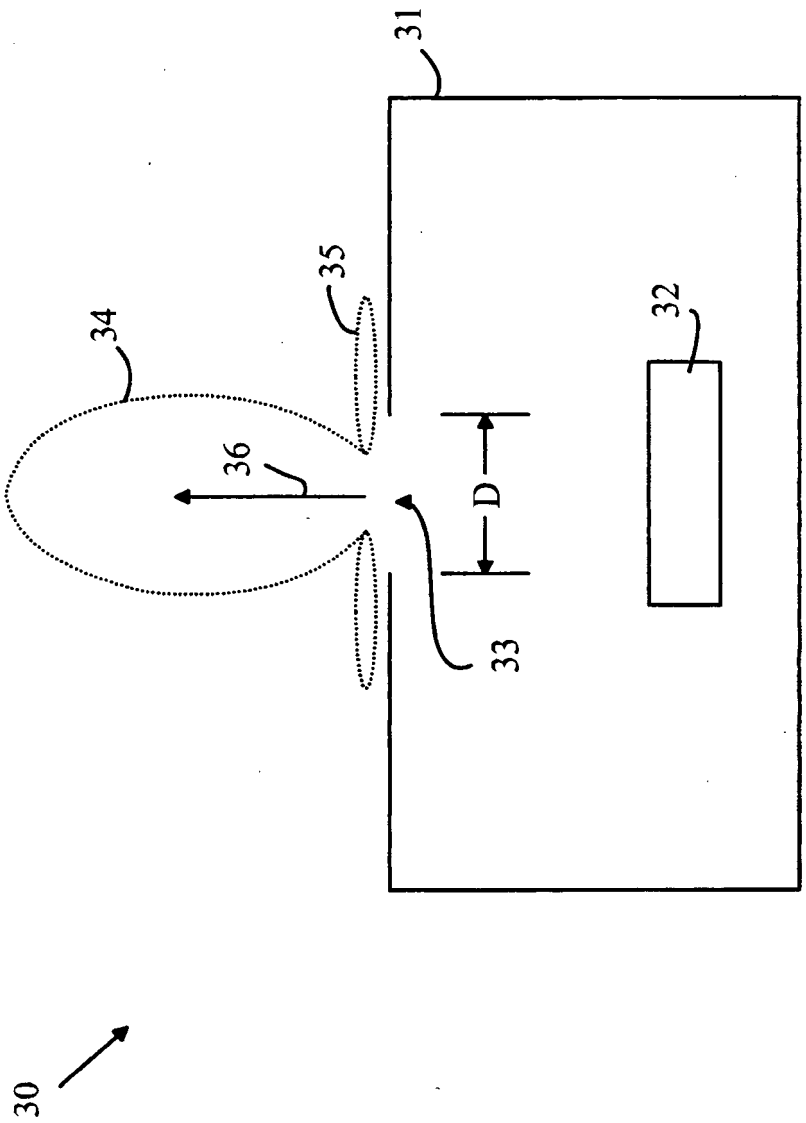


FIGURE 2

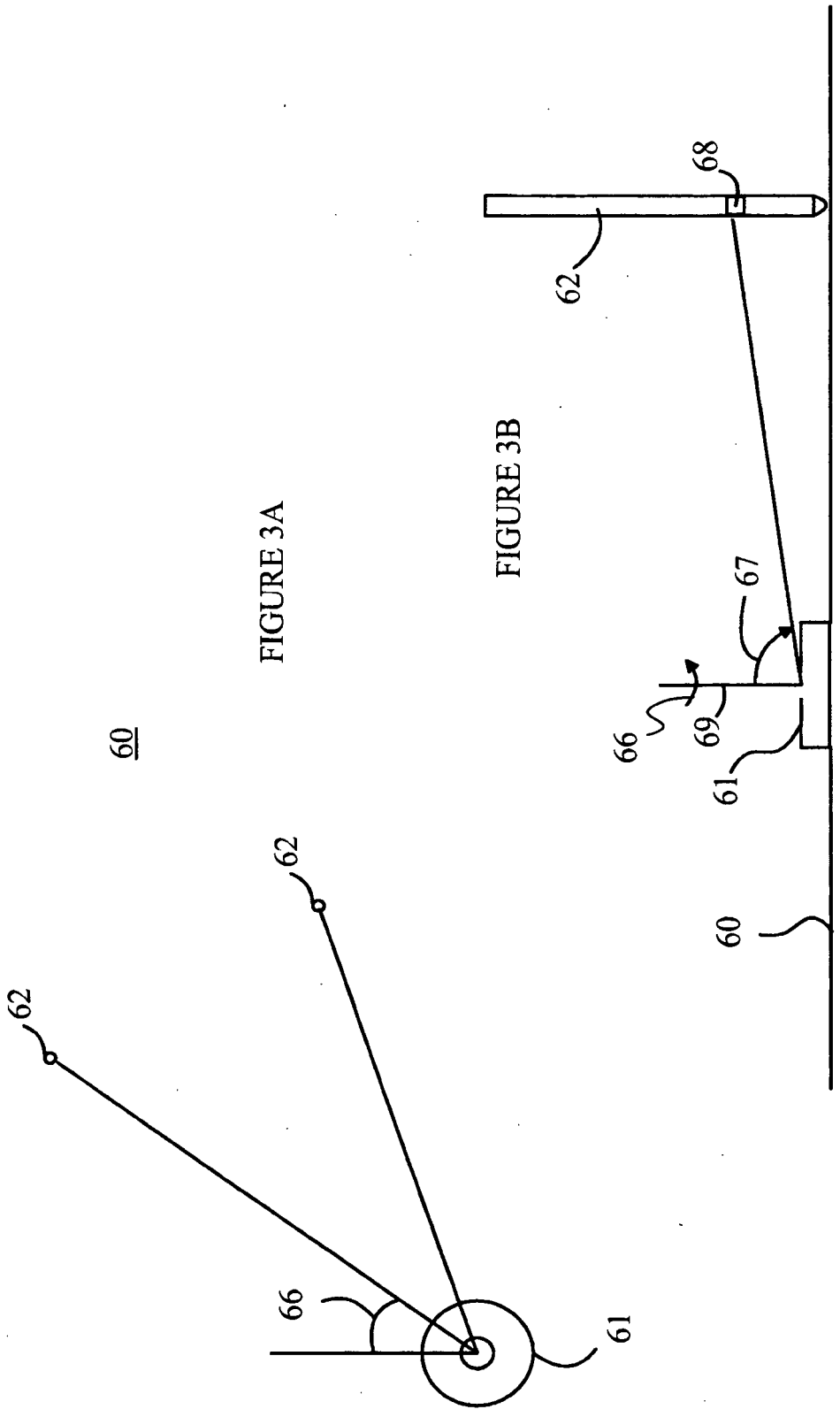


FIGURE 3A

FIGURE 3B

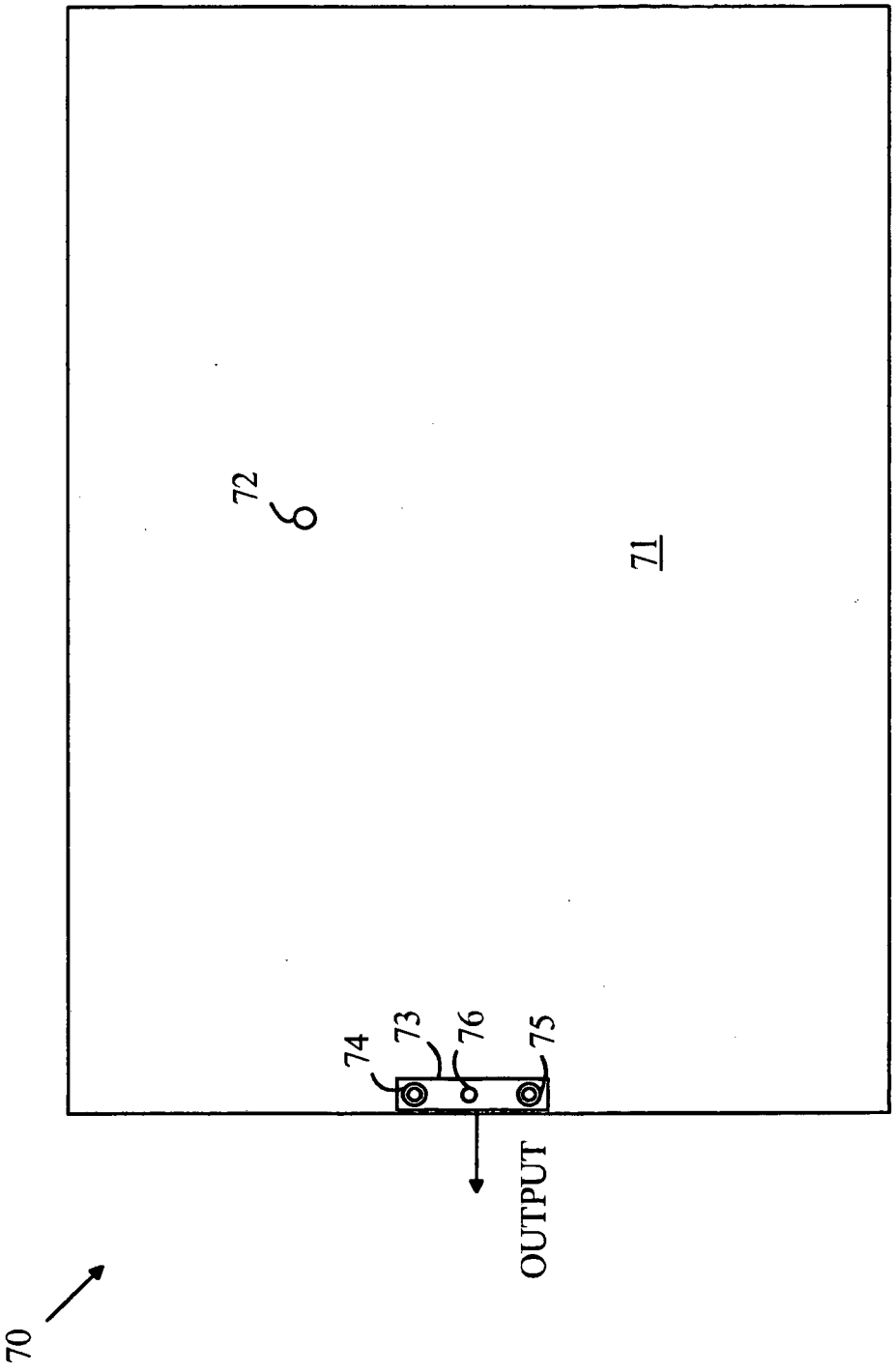


FIGURE 4

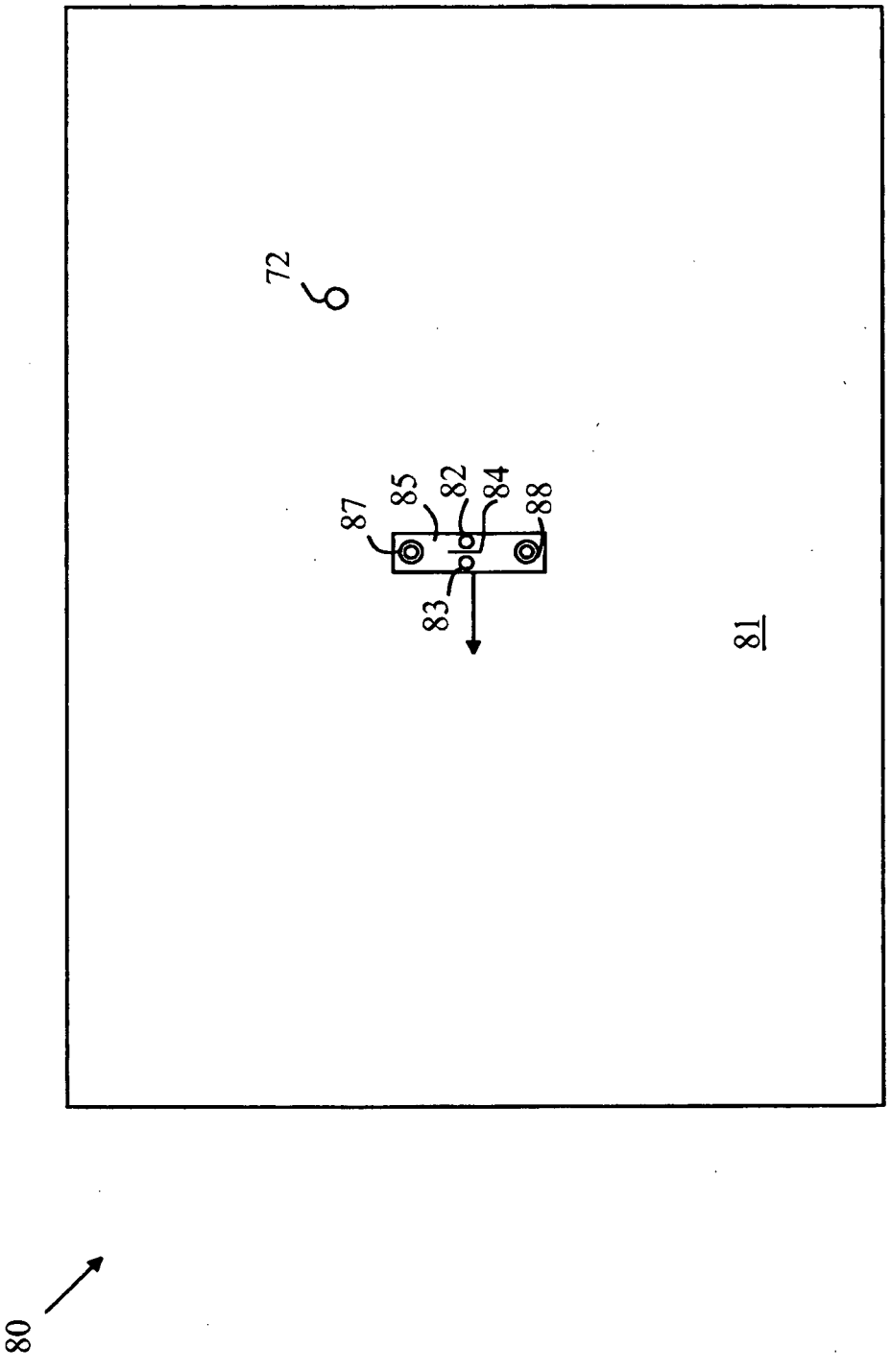


FIGURE 5

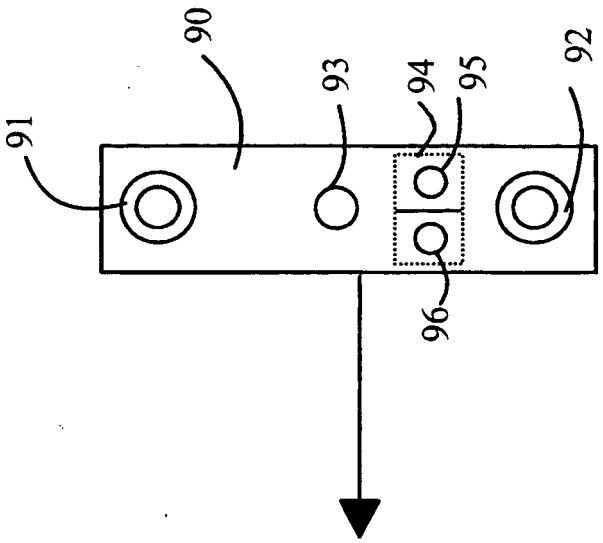


FIGURE 6

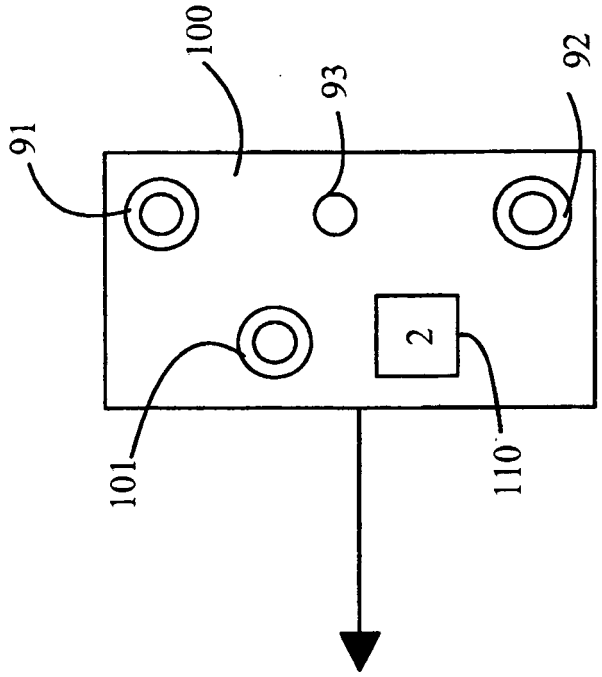


FIGURE 7

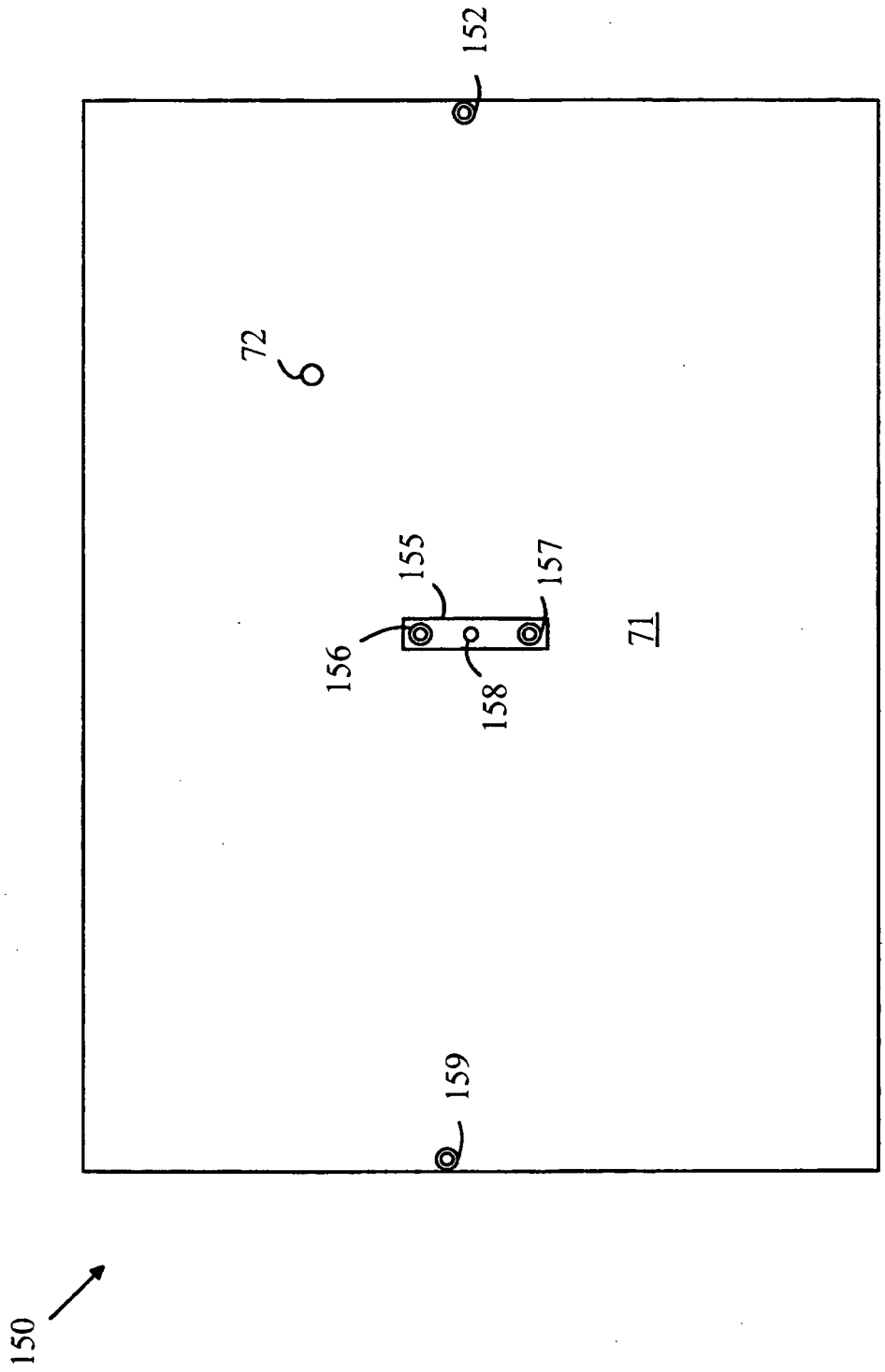


FIGURE 8

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 7489308 B2 **[0005]**